Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

ments should not counterbalance their utility: and, I flatter myself, there can be no objection to this mode on that score, because gate-hurdles are useful appendages to a farm, in any county, for other purposes, when not used on this occasion, and in this and other counties are requisite for dividing turnips for sheep; and, as to expedition, which is of great importance in harvets concerns, four of these hurdles, (as I have already observed,) may be fixed in five minutes.

Observation.—In countries, where hurdles are not in use, might not branches of trees, or any lumber of the farm-yard be substituted?

Extracts from an Essay on Irrigation; by the Rev. G. T. Hamilton.

(From the Letters and Papers of the Bath and West of England Society.)

Sec. I. *Influence of Water on Vegetation*

THE elements of fire and water, though in themselves of tremendous and destructive power, may be so managed and directed as to be rendered extremely subservient to the use and comfort of men. By the wisdom of Providence, the improvement of the material world depends on the combined efforts of human genius and labour; and philosophy must be invoked for the amelioration of the blessings of nature. By her aid, that which we should otherwise deplore as an evil is often converted into a benefit; and that which one person rejects as a nuisance, is caught and employed by another as a source of inestimable advantage. The element of water affords a continual illustration of the truth of this remark. The influence of water on vegetation is so obvious and striking, that since the experiments of Van Helmont, Boyle, and Du Hamel, most naturalists have considered it to be the *primum mobile* of growth in plants, and the most useful material which enters into their composition. Indeed all the experiments of naturalists and husbandmen unite in proving the vast utility of water; and its superior importance over every other material for promoting vegetation. The general fertility of moist situations; the rich production of irrigated meadows; the superior productiveness of lands situated upon brooks and rivulets, over such as are dry and arid; and the astonishing fertility of Egypt, by the periodical inundations of the Nile, justly considered by the natives as the peculiar gift of Heaven; afford incontestible proofs of the great utility of water in enriching the ground, and promoting the vegetative process in plants. The manner in which water acts upon the organs of plants and vegetables, has been accounted for by that eminent inquirer into nature, M. Fourcroy, in the following manner. The water is absorbed by the roots of the plant, and passes up through the stems into all the different parts, exudes from the leaves, and returns to the atmosphere; and in proportion as the roots are less or more furnished with moisture, every tree or plant grows and passes through its vegetative functions with more or less vigour. Water, thus filtrating through the roots of plants, becomes the vehicle for carrying into their vessels or organs every alimentary substance that is contained in the earth or soil in which they grow, and which it is capable of dissolving. Hence, in proportion to the quantity of water absorbed by plants, the nourishment derived from those other matters which it conveys must be the more abundant. In thus entering perpetually into the vessels of vegetables, to which it carries the various substances necessary for augmenting their component materials, and causing their growth and increase, it is obvious that water fills, distends, swells, and lengthens those vessels or canals, supporting and preserving the cellular and vascular plexus of their structure, by a proper distension of their parts. Hence in long droughts, or when burnt up by scorching winds, or the too fierce action of the sun's rays, plants become languid and withered, their leaves supple, drooping, and threatened with speedy death; but on the supply of sufficient moisture they quickly revive, recover their erect posture and healthy appearance, and resume their growth with renovated vigour.

II. *Irrigation not of modern Invention.*

Immemorial and extensively beneficial has been the practice of conducting water in furrows over the surface of the ground to promote fertility; and except in situations where immense beds of subterraneous sands absorb the snperinduced streams, no mode of cultivation has been more productive. Tradition reports, that a poor harmless man, extremely weak in intellectual faculties, spent much of his time on the banks of a contiguous river, amusing himself, especially when the stream rose to a level with the banks, by making small furrows for conducting the rising flood into the adjoining plains. A season or two passed, when the farmer observing that the lands thus floated produced daisies and grass with more luxuriance than formerly, and recollecting the cause, tried the experiment with great success. Thenceforth general practice was the source of general improvement, in situations where the trial was practicable. Whatever may be in this, that the hint of floating plains from muddy rivers is not of recent origin, we learn from the scriptures, the most ancient of all compositions, where the allusions are frequent to those streams and canals of water. Egypt, the ancient granary of the world, owed its abundant fertility to the waters of the Nile being distributed over a plain of 700 miles long, and from 300 to 400 broad. Nor was the practice of watering the soil unknown either to the Greeks or Romans, as we find from the writings of Homer and Virgil, though they considered it more in the view of moistening than of manuring the surface.

The scheme of watering meadows for hay and pasture, was practsed in England so early as the reign of Queen Elizabeth and James I. by one Rowland Vaughan, on the borders of Wales, and in the golden valley of Herefordshire, who also wrote a treatise on the subject. A more improved system of irrigation, however, was established in the counties of Gloucester and Wilts, during the last century, with remarkable success; and has of late been widely disseminated in many other districts both of England and Scotland.

III. *Advantages of Irrigation.*

"The irrigations of the Nile, of Spain, and of France," says Mr. Tatham, in his ingenious work on National Irrigation, "afford many examples which deserve the notice of the nation, and the practical farmer; while the English counties, on the other hand, remunerate lessons to those who have taught them. None of them are without some peculiar point of instruction. Lincolnshire affords examples for low and sunken grounds; Gloucester and Wiltshire, a complete system for level meadows in ordinary; Cheshire, a singular method of procrastinating water on hilly lands; and Devonshire combines the watering of meadows, with the means of conveying its produce."

The only objections which have been adduced against the practice of irrigation are so extremely futile, as to require no extraordinary arguments to surmount them. The expense of laying out and enclosing is urged as the principal obstacle to the more general formation of water meadows. But when the expense is moderate, and the meadow succeeds well, a single year's crop will entirely cover the outlay; and even when matters are less favourable, they may generally be liquidated in the course of two or three seasons at most.

Another objection, which has been mentioned against the watering or floating of land, is the danger of occasioning the rot among sheep. But this arises entirely from want of practical information, as this disease is the consequence of *summer watering*, which is carefully avoided by every enlightened irrigator, who means to eat the pasturage with this species of stock.

The advantages of irrigation, on the other hand, are many and great.

1. There is an increase of winter food, which the farmer may either convert into money, or, by wintering a greater number of cattle, afford an annual extra supply of manure for enriching other fields, and the manure again obtained from that produce becomes an additional source of national wealth.

2. An early growth of meadow grass enables the farmer who has a breeding stock to furnish abundance of food for the lambs and weak ewes during the spring, where no turnips are raised, or after they are eaten, before the natural grass rises; an advantage which the sheep farmer only can appreciate. The forwardness of grass from watered meadows is such, that the feed from March to May is worth two guineas per acre; and in June an acre will yield two tons of Hay, which may be moderately valued at five guineas; and whether the summer prove wet or dry, another guinea is generally obtained for the aftermath. At the above moderate calculation, an acre of well-watered meadow will produce eight guineas per annum.

3. Another important advantage attending these meadows is, that the store farmer can thereby raise abundance of food for his numerous flocks against the emergency of winter storms, by which the immense expense and risk of snow retreats are completely obviated.

4. The system of watering meadows is not only of advantage to the sheep farmer, in supplying him with early and abundant pasturage for his stock, but it is also highly beneficial to the dairyman, inasmuch as it enables him to begin the making of cheese at least a month earlier than his neighbours, who have not the same advantage.

5. Lastly; land subjected to this management, whatever be the nature or quality of the soil, is raised to double or treble its former value, requires no dung, and is continually improving in quality. Every large and copious stream abounds in manure of the most fertilizing quality, capable of enriching land to any degree, whatever be the nature of the soil, or sub-soil, and an entirely new soil is, in a few years, superinduced on the primitive surface. By the irrigation of Aberdeenshire, and various other districts in Scotland, it has also been demonstrated, that

even the barren heath may be converted into grass by the simple process of irrigation.

Considering the great advantages to be derived from the practice of watering meadows, and the many undoubted testimonies in its favour, Mr. Wright expresses his surprise that it has not come into more general use, as there is not a stream of water upon which a mill can be erected, but what may be made subservient to the enriching of land. "I am confident," says he, "that there are in each county in England and Wales," he might have added Scotland and Ireland, "2000 acres upon an average which might be thus treated, and every acre increased at least one pound in annual value." The general adoption, therefore, of the system of irrigation throughout the united kingdom is capable of being made a national advantage of at least half a million per annum, besides the great improvement of other land arising from the produce of the meadows, and the employment of the industrious poor. "Whenever I pass by a rapid river," says Mr. Wright, in his treatise formerly quoted, "and see no use made of the many tons of rich manure suspended in its waters, and thereby irrecoverably carried into the ocean, I cannot help feeling this as a momentous loss to the community."

"Those who have never had the opportunity of seeing the effects of watering," say the Monthly Reviewers on this article, "will be disposed to think Mr. Wright has somewhat exaggerated; but we who have ourselves seen and experienced the effects of this improvement, have no doubt of the facts, and therefore warmly recommend the subject to the attention of our agricultural readers."

IV. *Formation of Water-Meadows.*

The great principle of a water-meadow is, the power of bringing on and carrying off the water at pleasure; and the primary objects are, a deposite of manure from the water, and shelter for the land from the winter cold. And provided these great objects can be accomplished, the shape or uniform disposition of the meadow is not material. Should the operations be commenced without previously using the requisite steps in the formation of the meadow, instead of making an improvement, the land will be damaged, and a heavy expense incurred.

Mr. Wright considers the solution of the three following questions as a necessary preliminary to the operation of watering. 1. Whether the stream of water will admit of a temporary dam or weir across? 2. Can the farmer raise the water by this means a few inches above its level, without injuring his neighbour's land? Can the water be drawn off from the meadow as quick as it is brought on? If a satisfactory answer can be given to these questions, he advises to proceed to the formation of the meadow.

1. In the laying out a meadow for the purpose of irrigation, a careful inspection is, in the first place, essentially requisite, to consider what drainage may be necessary, and how the same may be most advantageously performed; as in many situations, the drains necessary for irrigation may be so planned, as to serve for the land also; and in other situations, the master feeder, with the additional expense of thorns, may be rendered a good fence. If due attention is not paid to the article of drainage, in the formation of a meadow, little advantage can be expected from the undertaking; for the ground will continue wet

and spongy, and the grass of course be thin and weak.

2. The attention of the irrigator ought next to be directed to the course of the river whence the meadow is to be supplied, and to the most eligible places for erecting weirs and flood-gates. The water of a small gentle rivulet may be diverted by means of a few sods, with stones laid above them. But for a small river, the weir ought to consist of several rows of stakes, interlaced with branches of fir, and the intervals of the rows filled with stones. The sand and mud that descend with the floods fill up the interstices, and in heavy rains the superfluous water passes freely over. For more powerful rivers, the weir is constructed of strong frame works of wood, firmly jointed together, and the compartments paved with large stones or bricks, the weir to rise very gradually against the current, and to slope gradually away before the stream as it flows over it. The flood-gates should be made of the best oak, and the whole of the mason work should consist of hewn stone. Gates constructed in this manner, if properly managed, will last for ages.

3. The next thing to be attended to, is taking the necessary levels, and comparing them with the river, that the particular spot may be fixed upon, where the conductor and main feeders are to originate. This being ascertained, the conductor, or main carrier, and master drain, are first cast. The former, by which the water is conveyed from the stream into the meadow, is generally an open ditch, cased and paved with brick or stone: it should take the water from the bottom of the stream, and leave it in the highest part of the meadow, from whence it may pass in feeders to the soil. A ditch, ten feet wide, and three deep, will commonly water ten acres of land; but much depends on the rapidity of the water's motion, and something also on the state of the soil, and form of the ridges; for if the soil be very open, it requires more water to float it, and if the ridges are high raised, and decline much, the water passes quickly over them, and requires a full supply: on the other hand, if the water move quickly in the conductor, and amount fully to the depth of two feet, a meadow of fifteen acres may be watered by it in successive divisions.

4. The conductor being finished, the sluice and the hatches fixed, and the main feeders and drains formed, the water may be admitted into the highest part of the meadow. If the ground to be watered has been formerly arable, and formed into large ridges of ten or twelve yards broad, the easiest method is to cut a channel for the water along the top of the ridge, to allow it to run over on each side; throwing here and there obstructions in its way, to turn as much of it as may be requisite to float the surface of the ridge, and then to be received by the furrow between it and the next ridge, which delivers the water into the main drain to be carried off the field. But when the land intended to be watered has not been previously in a state of aration, it is necessary to new-model the surface, otherwise, the water, which will always find its level, would lie too deep, or move too slowly over the low places in the ground, and thereby injure the grasses, by a redundancy of water, while all the higher parts of the ground would appear like little islands above the surface of the water, and consequently receive no benefit from such an imperfect system of irrigation.

In constructing the breadth of the

beds or ridges, the form of the land and the quality of the water must be taken into consideration Where the land is flat, 37 or 38 feet is deemed a proper breadth; but if the ground be of a convex form, or if the water contain any calcareous particles or substances, such as lime, marl, and the runnings of a town, the beds may be enlarged even to 42 feet, which, in general, is reckoned a good medium breadth. In many cases, it is essential to economise water; on this account, it is generally necessary that the declivity of the land, if artificial, should be made gentle; and if naturally rapid, that it should be counteracted by checks. If the water which is conducted upon grass land passes with a very rapid current, the deposite of whatever fertilizing matter it may contain, will be carried away by the stream: on the other hand, if the water remains stagnated, the natural herbage becomes languid, and yields to aquatics. The superfluent water should then pass in a thin and even, but a languid current; and it is of the highest importance, that after it has performed its office, it should be made capable of being drawn off without delay.

"Where the inequalities of surface are large and numerous," says Mr. Smith, "it will be attended with much more expense to make such land into a regular form for floating, on account of the great expense of wheeling the earth from the hills to the hollows. In these cases, it is necessary (to avoid expense) to adopt an irregular method of floating: by taking advantage of such irregularities of surface, a meadow may often be floated at a quarter of the expense required to put it in a regular form; and this method is found to answer the purpose very well, if the works are carefully laid out with the spirit level. When the fall of water is ascertained, the form of the ground is the next thing to be attended to; if there are no natural declivities in the surface, down which the waters may run from the overflowings of a cut in the summit into a drain in the hollows, so that the water may keep constantly running down such slopes, by a regular current, which prevents a diminution on the ridges, and a quick discharge in the lower drain; to avoid an accumulation in the furrows, it must be made with good slopes, and plenty of drains. These, with a constant supply of water in the winter, are the most essential parts of a water meadow The water must be kept constantly moving over the surface; and the practice proves that where the water moves the quickest, there is always the most grass. In short, the great matter is, to make the water run from one to two inches deep, over every part of the field, and to keep it in perpetual motion.

"The rate of declivity, from the feeder to the drain, found to be most advantageous, is about one inch in the yard, and from the upper to the lower extremities of the ridges, one inch for every nine yards The bank on the back of the feeder should be formed with the earth which comes out of it; and if more is required, recourse may be had to that which is cast out of the drain. In case of a short supply of water, according to the best principles of irrigation, it will be better to unite all the water upon such a portion of the meadow, as it is capable of covering well, and to allow that part to have the full benefit of the water as long at a time as is necessary, or as long as it may be kept off the other parts, without injury. When the meadow consists of several pieces, one part should be got ready first, and the water put on it, whilst the rest are preparing.

"The ridges being formed, and all the feeders and drains cut out, and their materials placed in such a way, as to render the surface as regular and correct as can be accomplished at first, grass seeds ought to be sown, of the most proper kinds which can be had, corresponding to those which the soil and water are known to encourage. If the meadow be ready in spring, the seeds may be sown with a thin crop of barley or early oats; but it may answer as well, perhaps, to have the meadow prepared about Lammas, and then to sow the seeds without corn."

Catch-Work Meadows.

As very little land, comparatively, can be entirely commanded by water, without reducing its inequalities by manual labour, it has been found expedient to adopt a different kind of water meadow for land lying on declivities, which must be irrigated by springs or small brooks. As this operation must be seen to be properly understood, it is almost impossible to give any intelligible written description of the process without the aid of diagrams.

If the water to be used can be led by a narrow channel with a gentle descent to the sloping surface of grass land, a considerable extent of ground may be irrigated with a small quantity of water, at a very trifling expense. The feeders and drains are cut in a direction passing across the slope of the surface intended for irrigation, and the water may be introduced at an upper corner, where it passes gently, and by a small declivity in the feeder, across the slope, and overflows the surface below its tract with a thin sheet of running water. A drain, at a proper distance below, receives the water, and transmits it into another feeder, cut on the same plan as the former, where it again overflows, and is again taken up in a drain, to be sent over new surfaces; the drains in the first process operating always as feeders in the second, and *vice versâ.* Land of this description may often be watered very fully by means of simple furrows or drains, formed by a sagacious labourer with the plough, in order to prepare for corn.

This kind of water-meadow is seldom expensive. The stream of water being usually small and manageable, few hatches are necessary; and the land lying on a declivity, much less manual labour is required to throw the water over it regularly, and particularly to get it off again, than in the flowing meadows. The expense of forming such a meadow is usually from £.3 to £.5 per acre; the improvement generally from £.1 to £2 an acre The annual expense of keeping the works in repair, and watering the meadow, seldom exceeds 7s. 6d. per acre.

V. *Management of Water-Meadows.*

October and November.—About the middle of October, the after-grass having been eaten off, all the ditches, troughs, and drains, must be thoroughly cleansed by the spade and breast plough, from weeds, grass, and mud, and well repaired, if they have sustained any injury from cattle. The cleansings should be used, and trodden down even, in any parts of the meadow that are lower than the rest, to make every ridge a perfect inclined plane, and ready to receive the first flood that may now offer itself.

The effects of early watering are very important in strengthening the roots and stalks of the plants, and preparing them for shooting up strong and vigorous in the ensuing spring; and the blades that now rise form a rough coat against winter, protecting the vital organs of the plants from the winter cold. Besides, if the meadow must be watered in separate divisions, and at different periods, it must happen, that by delaying the operation till November, some parts of the meadow may receive no water sooner than December or January; and should these months be severe, it may become wholly impracticable to complete the operation at that season. The duration of this autumn watering ought to be about three weeks, with a dry interval of a day or two, and then the works are made as dry as possible to encourage the growth of the grass. Should the water now arrive in the shape or magnitude of a flood, as much of it as possible, without injuring the banks of the works, ought to be turned over the meadow, as the water at this season, being the first washing of the arable lands on the sides of the chalk hills, as well as the dirt from the roads, and runnings of towns and villages, is peculiarly enriching.

December and January.—The chief care of the irrigator now consists in keeping the land sheltered by the water from the severity of frosty nights. It is necessary, however, every ten days or fortnight throughout the winter, to give the land air, by taking off the water entirely, otherwise it would rot and destroy the roots of the grass. But in severe frosts, it is not very safe to remove the water, as it operates so far to protect the grass; and if exposed wet to frost, it might be greatly injured. If it be necessary to alter the water in such weather, it ought to be done in the morning of a dry day; and should the frost continue severe, it might be again covered during the the night. When the frost has given a complete sheet of ice to a meadow, it is adviseable to discontinue floating.

February and March.—In February every division of the meadow requires to be again watered; but at this season a more than ordinary degree of attention is necessary. If the water be allowed to remain on the meadow for many days without intermission, a white scum is generated, which is destructive to the grass, and warns the floater instantly to remove the water. Some meadows that will bear the water three weeks in October, November, or December, will perhaps not bear it a week in February or March, and sometimes scarcely two days in April or May. In the month of February two waterings, of five to seven days each, should be given; and in March three, of three to five days each, according to the state of the air, ever suffering the water to remain on longer in cool than in warm weather. In a late season or climate, it may be necessary to continue the watering to the end of March, and sometimes in high backward situations, to the middle of April. But in low warm districts, and in favourable seasons, the operation is finished in the end of February.

By the middle of March, the grass on the old floated meadows will generally be sufficient to afford abundant pasturage to all kinds of stock, and the water is then taken off for a week, that the land may become firm and dry for the admission of cattle. Rolling at this season is also deemed advantageous. The early spring feeding ought never to admit heavier cattle than sheep, calves, or young cattle; for large cattle do much injury by poaching the ground, destroying the trenches, and spoiling the grass. During the first week of spring feeding, if the season be cold or rainy, it is proper to give the cattle a little dry hay in the evening, to intermix with their moist food.

April.—In the course of this month, the grass of the water-meadows must be completely eaten off; for should the pasturing be extended to a single week in May, it is said that the hay crop will be ruined in quality, as it will prove soft, woolly, and unsubstantial, like an aftermath crop.

May.—The meadow having been eaten bare the preceding month, the water is now admitted for a few days, which will in general ensure a good hay crop, in the course of six or seven weeks. It is of great consequence to have the hay in ricks before the Lammas rains commence, which may be easily effected, if the stock is removed from the pasture by the first of May.

To prepare for aftermath pasture, or green house-feeding, the water may be again thrown over the meadow for a few days, and then left quite dry till the grass rise, and be fit for introducing cattle. But if sheep are to be admitted, no water should be used on any account, as summer water infallibly induces rot. It is notwithstaning remarked, that no watering is so enriching as that which is given during summer floods. In the practice of irrigation, meadows require a much greater proportion of days throughout the year to be dry than to be floated; and this proportion seems to vary according to circumstances in the soil, water, and climate; but all the periods of watering included seem to run between six and nine weeks throughout the year.

The superfluous water of navigable canals might be applied with astonishing effect to the purpores of irrigation. This patriotic measure was suggested by the Board of Agriculture, in 1796, in a circular letter to the Canal Companies; but with the circumstances which prevented this national measure from being carried into effect, the writer of this essay is entirely unacquainted. Of its practicability, and beneficial tendency, however, every person who has paid the smallest attention to the subject, must be convinced. The application of navigable canals to the purposes of irrigation, has been long practiced in the Milanese, and rendered that part of Italy among the most fertile and opulent in Europe; and by the economy of the waters of the Nile, an unrivalled fertility was spread over the sandy deserts of Egypt, and the Thebäis, and even over the scorching plains of Lybia.

The numerous lakes which exist in the United Kingdom, might also, at a trifling expense, be drawn off, and applied for the same beneficial purpose; by which our rugged fells and mountains might be converted into a beautiful green, the barren heath into fine sweet pasture, and the rushy fen into a fertile field, to the ultimate amelioration of the British fleece, and the increased wealth and prosperity of the nation at large. This is the dictate of Nature herself, if we would condescend to listen to her voice, or open our eyes to view her operations. Every little stream that rushes from the mountains, where it occasionally overflows its banks, has there meliorated the herbage, while all around is a dismal barren waste. Every where she points out this method of improving the soil, but we have not yet learned to obey her voice, or to copy the example which she daily sets before us!

On the Management of the Onion; by Thomas Andrew Knight, Esq. F.R.S., &c.

(From the Transactions of the Horticultural Society of London.)

The first object of the Horticultural Society being to point out improvements in the culture of those plants which are extensively useful